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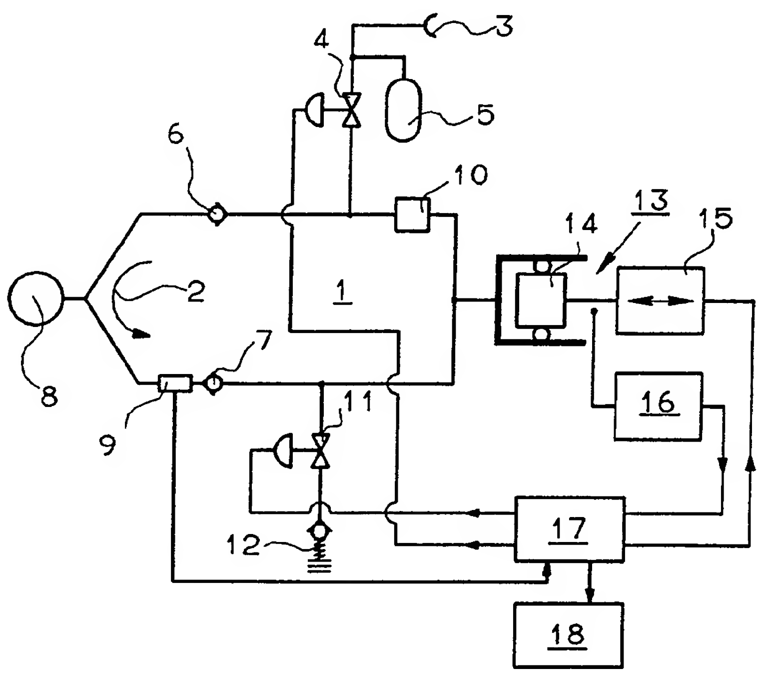
(54) Method of calibrating a flow sensor in a respiratory system

(57) A method of calibrating a flow sensor (9) in a respiratory system (1) having control elements (4, 11) in the respiratory system (1) for the purpose of influencing the respiratory gas flow, is improved with regard to the influence of the composition of the respiratory gas. In order to achieve this object, it is provided that, for the purposes of calibration, the control elements (4, 11) are switched to a closed respiratory system with directed respiratory time-volume relationship, conveys the respiratory gas in the respiratory system (1) via the flow sensor (9). By comparing the time-volume relationship with the measurement signal of the flow sensor (9), a calibration value can be obtained for the flow sensor (9).



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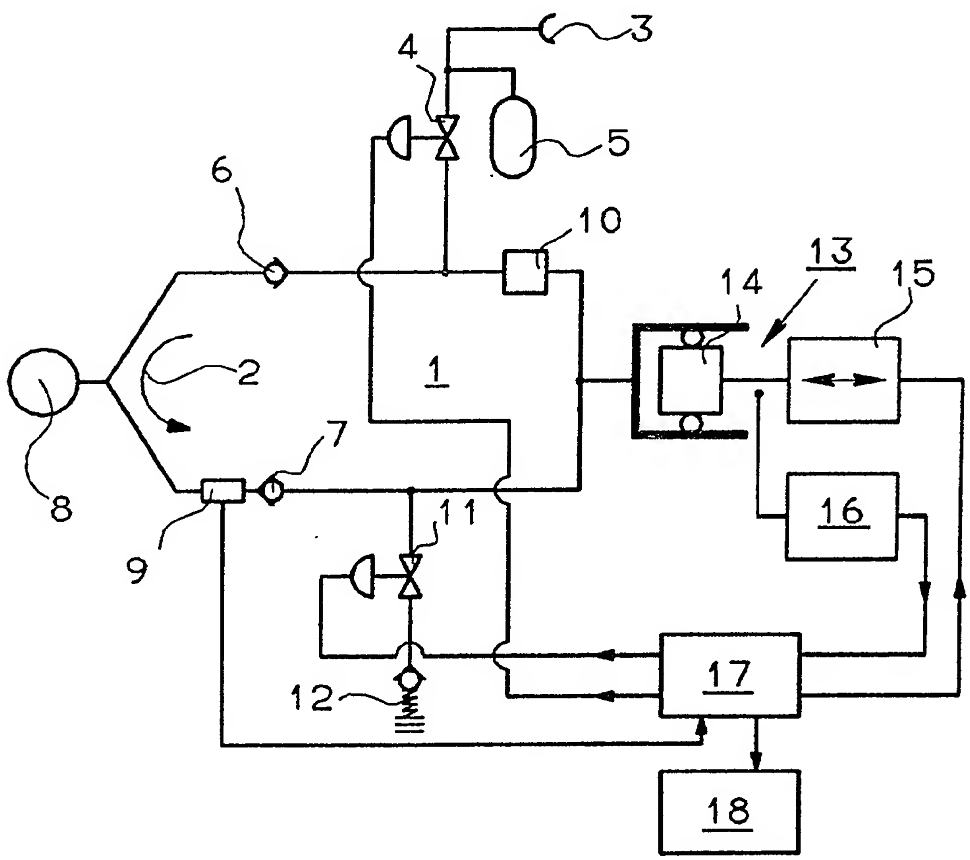
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METHOD OF CALIBRATING A FLOW SENSOR IN A RESPIRATORY SYSTEM

This invention relates to a method of calibrating a flow sensor in a respiratory system.

A respiratory system containing a flow sensor is known from GB-A-2164572. This respiratory system contains stop valves as control elements and directional valves which control the direction of the respiratory gas flow. Fresh gas is fed into the respiratory system via a fresh gas connector and a first stop valve. On the inspiration side, the respiratory gas flows, via a carbon dioxide absorber, a first directional valve and a pressure sensor, to the lungs of a patient. Located on the expiration side, there are a flow sensor and a second directional valve, via which respiratory gas is directed back into the inspiration branch. Provided in the respiratory system, there are a second stop valve for releasing excess respiratory gas and a drive unit with a variable volume, the drive unit conveying respiratory gas to the lungs of the patient in a rhythmic sequence. The temporal course of respiration is controlled by a control unit.

Various forms of respiration can be achieved by means of suitable activation of the stop valves. A so-called "closed" respiratory system exists if only so much fresh gas is dosed into the respiratory system as was consumed by the patient, whilst, in the case of a "semi-closed" respiratory system, the system is operated with a excess of fresh gas and after each respiration the excess respiratory gas is released from the respiratory system.

Respiration is monitored by a pressure sensor which measures the respiratory pressure and a flow sensor which measures the volume expired by the patient. The flow sensor commonly used is one based on

constant temperature (hot wire anemometry). This measuring method is dependent upon the type of gas, and a reference value for "zero" flow must be obtained. With regard to correction for the type of gas, compensating methods are known which are able to take into account, in an adequate manner, the compositions of binary gas mixtures containing known components such as, for example, laughing gas and oxygen. These compensating methods are not, however, able to correct for gas mixtures which contain more than two components. Three components are present, for example, if, in addition to oxygen and laughing gas, anaesthetic is also dosed into the respiratory system. The influence of the anaesthetic on the flow measurement is negligible if small amounts, up to approximately 4%, of anaesthetic are used.

In the case of anaesthetics to be dosed in high amounts (up to 20%), on the other hand, a reduction in the measuring accuracy of the flow sensor can be expected.

The reference value for "zero" flow is usually obtained by switching off the drive unit, whereby a reference value is obtained without there being any flow of respiratory gas. It is, however, also possible to determine this reference value during the change-over between inspiration and expiration.

The object of the present invention is to improve the method of calibrating a flow sensor in a respiratory system.

The object is achieved in that for the purposes of calibration the control elements are switched to a closed respiratory system with directed respiratory gas flow, and the drive unit with preset time-volume relationship conveys the respiratory gas, which is located in the respiratory system, by way of the flow sensor, and by comparing the time-volume relationship

with the measurement signal of the flow sensor of calibration value is formed for the flow sensor.

According to the present invention, there is provided a method of calibrating a flow sensor in a respiratory system comprising (i) control elements which are arranged in the respiratory system for controlling the respiratory gas flow and (ii) a drive unit for causing the respiratory gas to flow in the respiratory system, which method comprises switching the control elements to a position such that the respiratory system is closed, and causing the drive unit to convey the respiratory gas through the flow sensor at a known time-volume relationship to obtain from the flow sensor a value of the flow, whereby, by comparing the known time-volume relationship with the value obtained from the flow sensor, a calibration value for the flow sensor can be obtained.

The advantage of the invention lies in the fact that respiratory gas in the closed respiratory system is conveyed by the drive unit, at a preset time-volume relationship, through the flow sensor, and, by comparing the volume conveyed per unit of time with the measured value obtained from the flow sensor, a calibration value is obtained for the flow sensor. Thus, the respiratory gas used for the purpose of calibrating the flow sensor has a composition which is precisely the same as the respiratory gas used for respiration itself. On account of the fact that the respiratory system is closed, no fresh gas can flow into the respiratory system and no respiratory gas can escape. The time-volume relationship is fixed in the control unit and transmitted to the drive unit. In this way, the respiratory gas volume per unit of time flowing through the flow sensor is known. The determination of the reference value for the "zero" flow state is carried out in a known manner, for

example, by measuring, with the flow sensor, a reference value in the case of stationary respiratory gas flow, before the drive unit is switched on.

It is advantageous for the drive unit to comprise a piston-cylinder unit and a drive means which has a position-determining device for determining the position of the piston of the piston-cylinder unit. In this case, it is possible to obtain an exact path-volume relationship. The time can be taken into account by ensuring that the piston travels back at a known speed, preferably at a known constant speed. The respiratory gas flows through the directional valves in the respiratory system such that the respiratory gas passes through the flow sensor in the expiration phase.

It is advantageous to carry out the calibration of the flow sensor in a periodic sequence. In this way, continuous adaptation of the flow measurement to the composition of the respiratory gas is possible. However, it is also possible in the case of sudden change of the composition of the respiratory gas, for example, in the case of transition from the introductory phase to the maintained phase of anaesthesia, to initiate a calibrating cycle by means of the control unit.

The invention will now be described by way of example, with reference to the drawing.

The single Figure of the drawing shows a respiratory system 1 in which respiratory gas circulates along the direction of arrow 2. At a fresh gas connector 3, fresh gas is fed into the respiratory system 1 via a first control element or valve 4, upstream of which there is connected a respiratory bag 5 acting as a buffer volume. A first directional valve 6 and a second directional valve 7 determine the flow direction of the respiratory gas to a patient 8 and back from the patient 8 via a flow sensor 9, which

measures the quantity of the respiratory gas which has been exhaled. The carbon dioxide exhaled by the patient 8 is removed from the respiratory gas by a carbon dioxide absorber 10. Located in the flow, downstream of the second directional valve 7, there is a second control element or valve 11 by means of which excess respiratory gas can be released from the respiratory circuit 1 via a non-return valve 12.

The respiratory gas is made to flow by a drive unit 13 which consists of a piston-cylinder unit 14 and a drive means 15. The position of the piston of the piston-cylinder unit 14 is determined by a position-determining device 16. The activation of the control elements 4 and 11 and of the drive means 15 is controlled by a control unit 7 which receives the position of the piston of the piston-cylinder unit 14 from the position-determining device 16. The flow sensor 9 is likewise connected to the control unit 17 and the measured flow values are indicated on an indicating unit 18.

The calibration of the flow sensor 9 is carried out as follows:

At the end of the inspiration stroke, the piston of the piston-cylinder unit 14 is located at its left hand position, i.e. the respiratory gas is conveyed completely into the respiratory system 1. Then, the control elements 4 and 11 are closed so that no fresh gas can flow into the respiratory system 1 and so that no respiratory gas can escape via the non-return valve 12. The "zero" flow value is then measured, as a reference value for the flow sensor 9, with the respiratory gas being stationary. Subsequently, the piston of the piston-cylinder unit 14 is moved to the right at a constant speed in a path-volume relationship that is preset by the control unit 17, so that the respiratory gas is conveyed via the flow sensor 9. By

comparing the measured value supplied by the flow sensor 9 to the control unit 17 with the path-volume relationship, a calibration value is obtained for the flow sensor 9.

In order to adapt this calibration to a gas having a different composition, it is advantageous to repeat the calibration at periodic intervals.

CLAIMS

1. A method of calibrating a flow sensor in a respiratory system comprising (i) control elements which are arranged in the respiratory system for controlling the respiratory gas flow and (ii) a drive unit for causing the respiratory gas to flow in the respiratory system, which method comprises switching the control elements to a position such that the respiratory system is closed, and causing the drive unit to convey the respiratory gas through the flow sensor at a known time-volume relationship to obtain from the flow sensor a value of the flow, whereby, by comparing the known time-volume relationship with the value obtained from the flow sensor, a calibration value for the flow sensor can be obtained.

2. A method according to claim 1, wherein the drive unit comprise a piston-cylinder unit and a drive means, and wherein the respiratory system comprises a position-determining device for determining the position of the piston of the piston-cylinder unit.

3. A method according to claim 1 or 2, wherein the calibration is carried out in periodic sequence.

4. A method according to claim 1, substantially as hereinbefore described with reference to the drawing.

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Patents Act 1977
Examiner's report to the Comptroller under Sec..on 17 (The Search Report)

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Relevant Technical fields

(i) UK Cl (Edition K) G1R (RV)
G1N (NEUR)

(ii) Int CL (Edition 5) G01F 25/00

Databases (see over)

(i) UK Patent Office

(ii) ONLINE DATABASE: WPI

Search Examiner

V FLETCHER

Date of Search

30 JUNE 1992

Documents considered relevant following a search in respect of claims 1 TO 4

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
	NONE	

SF2(p) HCS - doc99\fil000031

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

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